

What is claimed is:

- 1 1. A method for forming a wafer of a compliant composite substrate, comprising the steps  
2 of:
  - 3 a) selecting a first substrate material having a melting point of  $T_{m1}$ ;
  - 4 b) selecting a second substrate material having a melting point of  $T_{m2}$ ;
  - 5 c) selecting a joint metal with a melting point of  $T_m$ ; wherein
    - 6 i) said joint metal and said first substrate material form a first eutectic  
7 alloy at a first eutectic temperature  $T_{eu1}$  while said joint metal  
8 and said second substrate material form a second eutectic  
9 alloy at a second eutectic temperature  $T_{eu2}$ ; and
    - 10 ii)  $T_{m1}$  and  $T_{m2} > T_m > T_{eu1}$  and  $T_{eu2}$ ;
    - 11 d) depositing said joint metal on a side of said first substrate material to  
12 form a first intermediate substrate;
    - 13 e) depositing said joint metal on a side of said second substrate material to  
14 form a second intermediate substrate;
    - 15 f) forming a substrate pair by combining said first and second intermediate  
16 substrates such that said sides of said first substrate material and  
17 said second substrate material having said joint metal on them are  
18 against each other;
    - 19 g) ramping a temperature of said substrate pair up to at least  $T_m$ , whereby  
20 said temperature passes through  $T_{eu1}$  and  $T_{eu2}$ ; and
    - 21 h) cooling, after step (g), said substrate pair to form said compliant  
22 composite substrate.

1       2. A method according to claim 1, further comprising enhancing adhesion between said  
2           first and second intermediate substrates by preliminarily bonding said substrate  
3           pair.

1       3. A method according to claim 1, wherein the steps of ramping and cooling are  
2           conducted in a high vacuum.

1       4. A method according to claim 1, further comprising soaking said substrate pair, after  
2       ~~DD~~ step (g) and before step (h), for a specified period of time.

1       5. A method according to claim 1, further comprising forming a protective layer, before  
2           step (d), on said second substrate material on which epitaxial layers are to be  
3           grown.

1       6. A method according to claim 1, wherein said first substrate material is Ge and said  
2           second substrate material is Si.

1       7. A method according to claim 6, wherein said joint metal is Al + 1% Si.

1       8. A method according to claim 1, further comprising selecting a first thickness of said  
2           joint metal deposited in step (d) and a second thickness of said joint metal  
3           deposited in step (e) such that a total thickness ( $t$ ) of said joint metal is the sum of  
4           said first thickness and said second thickness, and said total thickness ( $t$ ) satisfies  
5           an equation  $t \geq D \Delta\alpha / \alpha \times 10^{-4}$ , where  $D$  is a dimension of said wafer, and  $\Delta\alpha / \alpha$   
6           is a ratio of a thermal mismatch between Sub1 and Sub2 which equals  $|(\alpha_1 - \alpha_2)| /$   
7            $1/2 (\alpha_1 + \alpha_2)$ .

1       9. A method according to claim 8, further comprising selecting  $\alpha_{eff}$  such that  $\alpha_{eff}$  is  
2           approximately equal to a thermal expansion coefficient of an epitaxial layer to be  
3           grown on said composite substrate.

1       10. A method according to claim 1, further comprising selecting a first thickness of said  
2           first substrate material and a second thickness of said second substrate material  
3           such that:

4       
$$\alpha_{eff} = (\alpha_1 t_1 + \alpha_2 t_2) / (t_1 + t_2)$$

5 where  $\alpha_{eff}$  is a thermal expansion coefficient of said composite  
6 substrate,  $\alpha_1$  is a thermal expansion coefficient of said first  
7 substrate material,  $\alpha_2$  is a thermal expansion coefficient of  
8 said second substrate material,  $t_1$  is said first thickness of said  
9 first substrate material, and  $t_2$  is said second thickness of said  
10 second substrate material.

1 11. A method according to claim 10, further comprising selecting  $\alpha_{eff}$  such that  $\alpha_{eff}$  is  
2 approximately equal to a thermal expansion coefficient of an epitaxial layer to be  
3 grown on said composite substrate.

1 12. A method according to claim 1, further comprising selecting said first substrate  
2 material and said second substrate material such that:

3 
$$\alpha_{eff} = (\alpha_1 t_1 + \alpha_2 t_2) / (t_1 + t_2)$$

4 where  $\alpha_{eff}$  is a thermal expansion coefficient of said composite  
5 substrate,  $\alpha_1$  is a thermal expansion coefficient of said first  
6 substrate material,  $\alpha_2$  is a thermal expansion coefficient of  
7 said second substrate material,  $t_1$  is said first thickness of said  
8 first substrate material, and  $t_2$  is said second thickness of said  
9 second substrate material.

1 13. A method according to claim 12, further comprising selecting  $\alpha_{eff}$  such that  $\alpha_{eff}$  is  
2 approximately equal to a thermal expansion coefficient of an epitaxial layer to be  
3 grown on said composite substrate.

1 14. A compliant composite substrate formed by the method of claim 1.

1 15. A compliant composite substrate formed by the method of claim 8.

1 16. A compliant composite substrate formed by the method of claim 10.

1 17. A compliant composite substrate formed by the method of claim 12.